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ABSTRACT

The consciousness of dizygotic twins in their communication of actions and events as seen in the visual cliff pictures published by E. J. Gibson and R. D. Walk (1960) was studied in Sweden. In the process of communication, many different state spaces are generated. The methodology demonstrates that ecological and biophysical properties of language produce unique morphological profiles. Four pairs of twins were exposed to these pictures in a classroom setting, and the text they built in response to the pictures was studied. The focus is on one pair of dizygotic twins between 16 and 17 years of age. At the kinetic level, stable relationships are identified among naturally occurring periods, mass, and length of text. The relating invariants are demonstrated through a multivariate statistical strategy involving an analysis of variance, an indexing of the size of effects, and a regression analysis. At the kinematic level, adiabatic trajectories are apparent, for which underlying state spaces and interrelated metrics are shown to be dependent on the particular text producer. It is made evident that a certain degree of consciousness is carried by a particular kind of concepts and conceptual relations. Finally, it is concluded that perceiving a phenomenon differs not only in degree but in kind from conceiving its consequences. Results also support the use of the Scanator methodology developed by B. Bierschenk as a way to keep track of unitizing activities. An appendix presents the original Swedish text produced by the four subjects. (Contains 18 figures, 7 tables, and 26 references.) (SLD)

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Abstract

This article has its focus on the consciousness of dizygotic twins in their communication of actions and events as perceived on the visual cliff. In the process of communication many different state spaces are generated. From a methodological point of view, it is demonstrated that the ecological and biophysical properties of language produce unique morphological profiles. Based on experimental data, collected from a male and a female pair, kinetic and kinematic invariants have been extracted. At the kinetic level, stable relations are identified among naturally occurring periods, mass and length of text. The relating invariants are demonstrated on the basis of a multivariate statistical strategy involving an analysis of variance, an indexing of the size of effects, and a regression analysis. At the kinematic level, adiabatic trajectories have become manifest, whose underlying state spaces and interrelated metrics are shown to be dependent on the particular text producer. It is made evident that a certain degree of consciousness is carried by a particular kind of concepts and conceptual relations. Finally, it is concluded that perceiving a phenomenon differs not only in degree but in kind from conceiving its consequences.

Central to the present study is the origination of "vocalised sound" and its sensitive dependency on the evolution of a language. Seen within a communicative context, there is a need for an ecological and biomechanical approach to language production. As demonstrated in Penfield and Roberts (1959), repeated excitation of the same brain tissue produces the same voices again and over again. A voice experienced again and again carries the same information as at any preceding occasion. It follows that intensity in stimulating various points of the surface of the temporal lobe enforces "vox". This is the classical Latin word for all forms of auditory effects. Penfield and Perot (1963) showed that its origination is crucially dependent on speech functions. For example, patients hear "voices", "sounds" and "melodies", when a damaged brain tissue gets a gentle electric shock. Their experiments stress the simulation of information which according to the "Gibsonian Law of Information" means information guided behaviour.

An organism is needed that does the "behavioural work" of distinguishing the effect of a first stimulation from successive stimulation, since a voice can only be experienced (Lat. 'audire'), if it is *subjected* to a distinction. When this behaviour effects voices that are experienced as calls upon distinct others, the calls carry *intentions*. Moreover, various *orientations* reflect differential attention to voices of others (Lat. 'ob-audire'). A macroscopic destination of the distinction of intention and orientation has been captured in the formula given in B. Bierschenk (1984, p. 11), namely:

{[(int.(A)] a [ort.(O)]} (1)

The foundation of formula (1) is made up by the following three postulates:

Postulate 1. A distinct call is indicative of an intention which is marked by the component [int.(A)]. This component is a token for the intentional state of an organism.

Postulate 2. The activity (a) of calling a unique name is indicative of an orientation which is marked by the component [ort.(O)]. This component is a token for the teleonomic property of calling.

Postulate 3. An individual organism provides the physical context for the proper co-ordination of the A- with the O-component. That is to say a productive constant (a) is the connecting component in the formula. The organism is viewed as a token of a biological system that provides a non-uniform co-ordinate space, where (A) and (O) intersect in (a).

Report on recent research within psychiatry (Skjöde, 1996) underpins that disorder in the working of the corpus callosum produces hallucinations. Excitation of the Wernicke area on the right hemisphere of the brain corresponds for example to the production of voices that act upon the subject (Lat. 'admonére'). According to Skjöde's brief notes, English and American scanning studies of various brain areas have shown that improper connections within some parts of the callosum are responsible for the hallucination of voices. Most important is the observation that patients become aware of admonitory experience when the frontal lobe is inactive. It implies that signals are crossing a threshold boundary when the control of the source of information is missing. Different voices emanate from "strange and unknown places" (Jaynes, 1982, pp. 106-112). The patient cannot decide upon whether the voices come from inside or from somewhere else. Thus hallucination leads to non-localisable intentional potentials that

are acting upon the subject. For the patient these potentials become the Agency of "God" or some other potential force e. g. "CIA".

The subject provides the ground for the working of a biological mechanism that is rooted in the AaO formula (B. Bierschenk, 1991, p. 8). The ability of an organism to transform sound into information depends on biological clocking mode or timing. Timing implies a sequencing of internally available sound. Thereby are the A's and O's of Expression (1) schematised within periods and fractions of periods. It follows that some time interval accounts for the periodicity in coupling of the components of the AaO formula. A strict sequential processing of AaO units (Lat. 'sequor') generates informational values as is indicated by different degrees of changes in volume as well as in texture. Conceived this way means that growing magnitudes and changes in direction results in an intentional potential that is strong enough, to break down what Jaynes (1982) calls the "bicameral state" of the mind. The passive or *subjective* state of the organism becomes broken. The metamorphic result is vocalised sound that organises itself into a verbal out-flow. Thus, any discussion of vocalised sound of living and actively organising systems entails a definite standpoint on biological timing and the sequencing of verbalised experience. The character of becoming conscious implies the possibility of the emergence of self-organising processes.

From a metaphorical point of view, the self-organising process of verbalising experience has been comprehended by the Old German verb 'sagén', whose Middle High German form is 'sagen'. In the Dutch language it takes the form 'zeggen'. In English it is 'say', and in Swedish, it gets the form 'säga'. All these forms are relatives of the Latin form 'In-seque' that means "tell" or "narrate". When connected to physiological ecology it refers to a narrator and infers a synthesis based on both propriospecific and exterospecific experiences. Experience, according to Gibson (1979, p. 75), concerns a narrator's communication of a "point of observation that is surrounded by a world". It follows that periodicity is entering the narrator's ability to distinguish and to designate events as terminal states.

Terminal states infer that events begin and end abruptly. Basically, events are nested within events and this property manifests itself in the discontinuities of perceived flows. Accordingly, a narrator can only act on the basis of perceived processes, changes and sequences. In this context, he must use some method that allows him to tell what kind of objective (Lat. 'obiectus') he is seeing. Only positively charged objectives can enter or are going out of sight. In a sense, selective direction of an observer's interest toward a particular objective forms the foundation of seeing and saying. This notion of attention carries a basic quality. It is the result of following with one's eyes what is going or coming out of sight as opposed to going or coming out of existence (Gibson, Reynolds, and Wheeler, 1969). As hinted at by Gibson's assertion of direct perception, the Latin wording 'seque' incorporates the meaning of following or pursuing an objective. The relationship thus described, is rooted in the Old Indian hunting expression 'sácaté', meaning that a dog is tracking some prey.

Originally, it was exactly this relationship to which the sanskritic AaO formula has been applied. Affinity relates the dog to the prey. This is the fundamental observation about an intentional potential charging an objective. It indicates that the organism necessarily makes intentional use of changing relationships. For example, objects or events can change colour or appearance, or the individual may change its relative position. To be able to pick up this information directly from those changes in viewpoints and angles of inclination respectively, the individual needs to "see" the physical event from which it abstracts ecologically significant information.

It is important to observe that the sanscritic use of the AaO formula was concerned with "otherness". The dog's otherness is the prime example of a subject that

stands in opposition to the self. The self's own actions or own words enter this formula first with Kant's individualism. He reintroduced the AaO-unity as his axiom for the foundation of knowing. According to Kant, the knower is in the known and the conceptual tool for integrating temporarily separate objectives is the schematism of the AaO formula. Both Kant and Gibson agree that the schema is to be sought in natural law. Furthermore, it was Piaget (1978, p. 254) who pointed out that the schema is conserved in the behaviour of the organism.

The crucial "see-say" relationship may be circumscribed with the concept of transcendence. Accordingly, on the basis of invariants (Lat. 'stare'), the brain differentiates perception from action. As illustrated by von Frisch's bee, the behaving individual can observe itself through immediate information pick-up (von Frisch, 1967). That stimulation is necessary for the activation of the central nervous system (CNS) in the pick-up of information is a commonly accepted position. But stimulation of the receptors in the retina, Gibson points out, cannot be seen. Instead, the function of the retina should be thought of as a means of registering "invariants of structure" (Gibson, 1979, p. 56). This exposition is intended to transcend the gap between Kant and Gibson. Transcendence in Gibson's theory is captured by his concept of "affordance", and consequently refers to the concept of synthesis.

Gibson (1979, pp. 127-143) explicitly recognises through his concept of affordance the function of ego-motion. This function is basic and consequently encompassed in perception and action. Accordingly, all functional changes over time are transcendent. With this point of view, it is important to separate the invariants of structure of the objectives from the invariants of the structure of the observer's perspective. Only under this condition is the effect of the individual's action accessible and eventually measurable.

The structure of the lay-out of a particular environment (loosely speaking the objective) may remain stable over long periods of time or it may change from moment to moment. This is entirely dependent on the observer's point of observation. The notion structure here refers not only to the process of construction but also to the operation of the schematism and its relation to the given formula. In conceiving invariants as *formless* and *timeless*, one recognises higher-order functions. Therefore, it is always necessary to refer to some form of organisation.

If organisation effects a verbal flow, it follows that the flow cannot be studied without due consideration of the Schema axiom (B. Bierschenk, 1991). Consequently, the schematism of language must come under experimental control (I. Bierschenk, 1984), because as outlined by I. Bierschenk (1989) language is the carrier of the individual's perspective. Perspectivation is an activity that twines together the perceiver with the perceived. It designates one's environment through the medium of natural language. In this sense, articulation requires that Kant's outer parenthesis becomes operationalised. A detailed discussion, based on a historic time perspective, is to be found in I. Bierschenk (1989). The outcome of this discussion is summarised in the :

[A a (A a O)] (2)

The inner A-component in Expression (2) is the carrier of purpose and as such coupled with the ego-motion. The outer A-component is the super-ordinate and twines together ego-motion with the function of orientation. The shift from motion to orientation puts the inner expression into perspective, and intention becomes evident in the Kantian proposition of self-reference. One's self is the corner stone of governing and control processes that are nesting the A's and the O's of expression (2). By means of a

procedure that allows for self-indication, the subject (Lat. 'subiectus') is transformed from *being* into *becoming*. It follows that guidance and the control of 'nesting behaviour' in text production is fundamentally dependent on the feasibility of a differential approach to individuality, i. e., becoming.

The Differentiation of Becoming

Natural language constitutes the link between seeing and saying. As a consequence, the differentiation of becoming is tractable at the moment when textual agents begin to enter the process of communication. Textual agents have the function of *individualising* the process. Various degrees of individualisation can be made explicit as self-indication. It means a nesting of agents and objectives. If and only if the effect of nesting over levels of description can be demonstrated, sensation, thought and the experience of an environment surrounding (one + self), can all be linked to the measurable evidence of becoming. In the emergence of one's self has awareness of one's own existence (Lat. con + scius) found its proper expression. Moreover, formulating individuality this way requires the "teleonomic concept" (Monod, 1972). Strictly speaking, it follows that empirical testing is involved in the materialisation of consciousness as the "teleonomic function" of text building (B. Bierschenk, 1995, p. 16).

Scanator (B. Bierschenk, 1995, 1996), relates precise measurement and strict experimentation to consciousness. Compared to presently existing procedures, Scanator signifies an entirely different methodological approach. The method provides evidence to a successful differentiation and measurement of becoming and thus a lawful approach to the materialisation of intentionality. Furthermore, at present, Scanator is the only known method that can get hold of both differentiation and integration of subtle mental structures. The demonstration of its validity for ecological information processing will start with a re-observation of the functioning of the basic AaO-formula:

A	a	O	(3)
Distinction of unique agents	Identification of verbs	Distinction of unique objectives	

The purpose with the AaO at the kinematic level is a study of informational interactions. These interactions are expressed in the changing of the A's and O's. Expression (3) has the didactic function of framing empirical context of the individual. Its A- and O-components concern the distinction of unique agents and objectives. Only then can an orientation in the affinity relation of the AaO be given formal expression.

For example, why do individuals and groups of individuals synchronise their work and sometimes their general patterns of activity in a unique spatial manner? Sometime a single answer can be obtained but as a rule, possible answers involve a number of patterns of answers. With reference to language, intention and orientation are the two components necessary for self-reference. Relative to language development, it is the identification of verbs that makes the distinction of textual agents possible. Changing verbs reflect a co-operative process between agents and objectives whose outcome is the development of informational and thus dynamic trajectories.

If a trajectory develops into a stable and reproducible behavioural expression, it points to the operation of natural law and "lawfulness" is then the objective frame of reference. All that is required is that behaviour is conceived of as non-determinate. If this condition is satisfied, the AaO-units can serve as building blocks, and a dynamic regime provides for the steps necessary in a successful processing of ecological information. The fundamental principle is the rhythmic clock-like development of AaO-units into nesting relations. It follows that dynamic trajectories at the kinematic level of de-

scription need to be conceived of as determinate. This development is guided by ecological information.

Textual Agents and Objectives

What then is the meaning with introducing into the scientific discussion something as strange as an agent? A starting point for an exposition of its specification is the verb "intend". In order to be able to transit a border or threshold some minimum degree of intention is needed. This circumstance will be used in the attempt of (1) letting an intentional potential characterise the textual agents, and of (2) rooting biologically the process of text production in the behaviour of the individual.

The key to an assembling and disassembling of degrees of intention lies in the co-operation between textual agents and objectives. Whenever a textual agent through a verb is coupled with a textual objective, intention carried by the agent as its *source* is transferred to an objective that is its *sink*. Conceived from a higher level of description, AaO-units are charged with meaning and meaning is captured by Blocks (B. Bierschenk, 1995). Blocks are defining the fields of information flow that come into existence. The process of transferring information from one field to another is accomplished through textual agents. Disposing textual agents and objectives over the flow fields of information generates the layout of something potentially meaningful. From a matrix point of view, these potentials are the function of the co-ordinates where agent and objective reside.

Textual objectives are definable in relation to local boundaries. Potential meaning flows always downward and consequently, toward the end state where its concentration of information is at its peak. This means that any particular agent is physically connected to at least one named state. Named states constituting a dynamical system, are prototypes of objects and events. Farther, the strictness in the affinity relation of agent and objective determines precisely the transport process that is producing flows of meaning. In an instrumental perspective, this means that an agent necessarily must be causally linked to some state of meaning conservation. From a topological point of view, this "informational causality" infers that the agents are directly acting in the generation of point attractors. With reference to the kinetic level of text processing, this circumstance may be farther explained on the basis of the *mass* dimension involved in the production of a text.

Mass-dependent interaction. A physical modelling of the forceful interaction at the kinetic level involves energy consumption in writing and re-writing. It builds on a set of transformations that satisfy the assumption of *conservational closure of energy*. Typical of the physical principle, that is basic of language production, is that it concerns the paper-and-pencil system. This system is the only one that maps the conservation of energy across micro-macro levels. A mapping of energy distributions is achieved through graphemes. These are the physical particles assembling energy into various degrees of concentration in the conservation. The involved energy transfer processes within the AaO mechanism of communication are modelled into Expression (4):

[A [Text producer	a intend	(A (Textual agent	a action	O)] Textual)] objective	(4)

Expression (4) explains energy consumption both as divergence and particle. Energy is something that is quantitatively conserved within definite limits, but qualitatively

transformed into information. In the transformation of a system, internal energy processing requires for a book-keeping of changes in information an empty sheet of paper as necessary initial state. The sheet may be conceived of as uniform and infinitesimal organisation of "spatia". If the text producer is introduced as an *operator* that acts on functions like a "spatium", marked and unmarked spatia are resulting from these operations. In an ecological perspective, a marked spatium is reflecting a mark in "*ambient light*" (Gibson, 1979, pp. 16-19), while an unmarked spatium is equal to an uncharged, or for that matter a discharged and thus *dark* spatium that cannot reflect a mark. In this sense, it is an anti-mark. The absence of a mark in ambient light constitutes a perforation in a string of adjacent marks and thus a lack of information. From a thermodynamical point of view, it follows that the kinematic position of a mark and the momentum of all states (marked and unmarked) are no longer independent variables as in classical mechanics pertaining to the kinetic level of processing. For a bio-physical system producing text, it is impossible to predetermine a *closed information structure*.

Progressing from one spatium to another introduces non-equilibrium conditions. Moreover, charging a spatium correlates with irreversibility and discharging correlates with reversibility in the advancement of a grapheme production. In building up a text physically, the text producer in his writing moves from the left hand side of a sheet of paper to the right hand side. Even more important is the observation that writing is coupled with top-down progression. Since the speed in writing progression is quite uniform and always oriented downward, distance can serve as an approximate measure of time (T). These two operations yield a law of proper form:

$$T = \alpha_1 (A_1)\, \beta_1 (O_1) + \alpha_2 (A_2)\, \beta_2 (O_2), \text{ where index 1 and 2 denote the spatia} \quad (5)$$

The functional scales of the A- and O-variables are obtainable from the marginal means. When the variables of Expression (5) are coded in the form of a 2^2 -Table, the means (k) of affinity may be noted as

$$\begin{matrix} 1 & 0 \\ 0 & k\text{-}1 \end{matrix} \quad (6)$$

For non-affinity, the corresponding relationship may be written as

$$\begin{matrix} 0 & 1 \\ 1 & k\text{-}2 \end{matrix} \quad (7)$$

If m_1 of m observations is assigned the value 1, the mean value can be calculated by the formula:

$$m_1/m \quad (8)$$

The calculation of the Error Sum of Squares (ESS) of the binary variables of Expression (5) is not dependent on what kind of observation gets the value 1 or 0 respectively, because the variance of variables is according to Anderberg (1973):

$$\text{Var}\,(B_j) = E\,(B_j^2) - [E\,(B_j)]^2 = m_1/m - [m_1/m]^2 = [m_1\,(m - m_1)]\,/m^2 \quad (9)$$

The first step in a scaling of the physical relations in text production is a decision on measuring distance. As a consequence of the one-dimensional character of the distance

measure, the problem reduces to a Minkowski metric. This is to say that the order of the metric is one and distance is reduced to:

$$D = |x_j - x_k| \qquad (10)$$

Measuring time in the city-block manner has been discussed in Lorenz (1993). Results of the application of this metric to textual agents and objectives are available and the functioning of this measurement has been demonstrated in Helmersson (1992). The use of distance as measure of a clock-like and rhythmic forward progression corresponds to a pendular movement in text building (B. Bierschenk, 1993). The mechanical work of writing and rewriting carried out by the text producer results in many pendular swings. Likewise, the resulting dissipative processes operate on a great number of A and O variables and produce a language space that is multidimensional in kind. Some of its axes are stretched during transformation while other must shrink so rapidly that the developing texture cannot hold pace with the development of its volume. The internal frictions in text production, conceived of as a natural system, make a clock-like working necessary. It follows that text as a *clock-work* keeps the pendulum swinging rhythmically in the production of sequences of graphemes.

It may be easier to understand the kinetic properties of grapheme production if it is given a quarter turn counter-clockwise. The result is a graph of charged and uncharged spatia that can be looked upon as a dynamic trajectory. A trajectory of appropriate length will show states that repeat themselves but never duplicate exactly. The direction of displacement together with the distance from the point of reference define the position of a grapheme on the trajectory. On the other hand, direction of sliding the pencil over the sheet of paper (from left to right) together with the speed of sliding (from top to down) define the velocity of sequencing.

Thus text production resembles a system that is characterised by compactness. According to Kugler & Turvey (1987, p. 406), a compact system is "... a very complex dynamical system composed of functionally rich components and very many degrees of freedom". The property of compactness of natural language poses insurmountable problems to conventional approaches. It is therefore mandatory to inquire into the following postulation:

Postulate 4.There must be processes operating in the rise of a language system that can be utilised in order to give simplicity to the resulting output.

Method

One consequence of the postulate (4) is that the study of the text building behaviour by necessity brings the single individual into focus. It is expected that this individualistic approach yields a topology in which the governing law can be expressed as "the objective frame of reference" for a study of the evolution of consciousness over natural text production. Text building is very often related to the fitness quality of the individual. In this context, the identification of progress refers to one's successful comprehension of the compactness characterising language. Comprehension of compactness concerns a consideration of change on rather different time scales (B. Bierschenk, 1993, p. 7). The double aspect of time (outlined B. Bierschenk, 1993, Fig. 1, p. 5) relates change in form, structure and organisation to both development and evolution. Change conceived of in this way is at the thermodynamic level teleonomic in kind, and thus directed toward the establishment of a global state attractor. The goal is

therefore a similarity analysis that refers to the kinetic point attractors as well as to the kinematic state attractors.

In following Kugler and Turvey (1987, pp. 207-210), any biological system is conceived of as an abstraction of which the individual is a token. Any individual of a certain population represents a token of that population. In realisation, two individuals of a certain biological system (e. g. Dizygotic Twins) or two individuals of a particular biological organisation (e. g. Monozygotic Twins) allow for the comparison of similarity of transformations in the co-ordinate space of the token system.

The individual provides a unique physical context for expressing systems similarity. Genotypes of endowed individuality of a certain kind, coupled with particular phenotypes, may yield important insight into similarity and thus the evolution of consciousness. In the development of the individual's text as expression of his consciousness it is expected that selection pressure works. The greater its portion in text building the more appropriate is the level of expressing the natural law that defines the layout of the kinetic attractor states giving rise to his consciousness. Moreover, identification and analysis of just a few individuals would allow for the establishment of similarity in kinematic abstraction. It follows that the identification of stability and reproducibility in the dynamic patterning of natural periods is a necessary precondition in order to get hold of the directional selection involved in continuous displacement.

Finally, judging from informal discussions with parents of twins it is evident that these parents have the ambition of treating their twins alike. This observation may be taken as an indication of the absence of a pronounced and formalised policy. It follows that the base level of treatment assures that twins are "socially coloured" pretty much alike. However, the design of the present study circumvents the problem of environmental determinism versus genetic influence. Instead the focus of the design is on the importance of the biological determinants of text building behaviour. This leads to the postulation:

Postulate 5. Relative genetic relatedness between individuals has crucial consequences for an understanding of the quality in text building behaviour.

The way in which quality is observable through text production is essentially based on the rationale underlying the fifth postulate:
(1) twins will indicate the genetic forces effecting the development of text building, and
(2) twins will give an answer to the natural law that has moulded the mental structure.

Participants

It is generally accepted that monozygotic (MZ) and dizygotic (DZ) twins can be regarded as "experiments of nature" (Neisser, et al., 1996, p. 85). Twin studies are given notice by the nomological scientist, because they help to identify genetic and environmental influences underlying variations in behavioural characteristics. Segal (1993, p. 944) defines MZ twins as those who result from a single fertilised egg that divides between 1 and 14 days after conception. Farther, the members of a MZ pair are with very rare exceptions of the same sex. Neisser et al. (1996) describe MZ as individuals who have all their genes in common. They are of the same age and have been growing up in the same family. A pair (11, 12) of female MZ, for which these prescriptions are valid, has been studied in B. Bierschenk (1995).

DZ twins result, according to Segal (1993), from the fertilisation of two eggs by two separate spermatozoa. As a consequence, DZ share half of their genes by descent. But the genetic relatedness of DZ may vary as much as from zero and hundred per cent common genetic makeup. Farther, genetic relatedness is exactly the same as

for other siblings. It has been observed that they are approximately equal number concerning same or opposite sex. A pair (21, 22) of male DZ has been studied in B. Bierschenk (1996).

The continued experimental process of validating *Scanator* relates to considering the extent to which the previous results can be applied to the text building of newly selected pairs. The following selection of two pairs (31, 32) and (41, 42) of DZ of opposite sex refers to the same general gymnasium. The selected pairs are between 16 and 17 years of age and are attending different natural science classes.

Materials

The test material consists of a A-4 format picture. It is a reproduction of the visual cliff pictures published by Gibson and Walk (1960).

Design and Procedure

The circumstances for presenting the test material differed from previous procedures. The classes were instructed by different female teachers and the material was handed out without any preparation. But the assignment of writing an essay was given by the same female test leader in order to secure a minimum of uniformity in the given instructions. The production of the text was carried out with an interval of about two weeks. At each test occasion the respective pair of twins was exposed to the material within the context of 30 fellow students. This measure was taken in order to prevent the pick up of any clues to something extra ordinary compared to usual school work.

Results

This report on the results builds on the premise that the mechanism controlling text building behaviour is essentially of a biophysical kind that introduces a radically different perspective into the study of the twins. Once the experimental design is set up it is expected that the AaO-machine produces an orderly transformation of perceived events into a textual organisation of information picked up from these events. It is inferred that this mechanism works with clock-like precision in its pick up and transformation into text. Therefore, closely reproducible results are obtained from any individual system as long as no biological defects are penetrating its working mode. More exactly stated, the uncontrolled variations in text production are small compared to the effect to be expected when a change is imposed on a producing system. It follows that alterations of an individual system are followed by observable changes. Therefore, imposed alteration may safely be assumed to be the cause of the change in the reported observations. Rigorous demonstration of these effects may therefore be viewed as a safeguard against error arising from defects in the biophysical mechanism itself.

Compactness in the production of graphemes and spatia has been identified with the individual's sensitive dependency. In the previous discussion it concerned (1) the production mechanism, and (2) the displacements in textual movement. It follows that the expression of AaO-units as basis of a book-keeping mechanism must have reached a sufficiently advanced stage otherwise an evaluation of the mechanism becomes quite useless. Without the individual's sensitivity to its own text building and without its use of the produced text as resonance body, the text would have a completely different structure. There would be no measurable amount of mass. Likewise there would be no measurable length and therefore no progress toward *wholeness*. The phase of evaluation namely relates to possible courses that can be taken in text production. Thus usefulness addresses the sensitivity of Scanator as reflected in the precision with which it determines equality. It is the objective of the experiment to determine equality in the working of the AaO-mechanism.

The important phase of studying equality in the complex and dynamic interrelationships between various facets of Scanator requires full awareness of a manifold of uncertainties (i. e. uncontrolled variations) that can effect the processing of a text. When these effects become comparable with the expected effect, experimental control becomes mandatory. At present, the set-up of the experiment has the form of a 2^1-factorial design. This design assures that the source of variation is balanced. Hence, being a member of a particular pair of DZ twins is the "treatment" of nature and represented by a factor (A), whose possible levels are: a_1 = twins of pair 1 and a_2 = twins of pair 2. These conditions infer that the design is fully balanced and the factor is fully combined. Each experimental unit in one pair is treated in the same way as those in the other pair. According to Cox (1958), this situation can be expressed formally as:

[Change in the Observable (Y)] = [Mean effect of the changes in factor (A)] (11)

The corresponding ANOVA model is

$Y_{ij} = \mu + \alpha_j + \varepsilon_{ij}$, where
Y_{ij} = distinct measurement of unit (i) and treatment (j)
μ = general mean
α_j = treatment component
ε_{ij} = residual component

In Expression (11), an observable refers partly to a quantity that depends exclusively on the particular unit of the experiment, and partly to a quantity that depends on the treatment, i. e., the way the experimental units have been influenced. It follows that the factor (A) is nested within the observable [Y(A)]. Thus estimating a change in the observable depends on the grouping of the taken measurements. Studying the twins independent of their membership refers to independent processes at the kinetic level of text production. At the kinematic level membership infer a study of processes that generate qualitative shifts toward sensitive dependency and consequently an experimental reorientation with respect to the working of the AaO mechanism. The experimental evaluation is followed up on the zero hypothesis presented in B. Bierschenk (1996, p. 5), namely:

The individual parameters and their relations to the AaO mechanism are independent of some corresponding model components or steps in text processing.

Note: The formulation of the zero hypothesis is based on the intention of demonstrating the fact that the parameters and model components work independently within and between pairs of twins.

The measurement concerns a number of observations on twins as language producers. The Tables 1 to 3 of the Appendix show that these observations are related to a small number of observables. The statistical procedure followed has been outlined previously (B. Bierschenk, 1996, p. 6). It confirms the zero hypothesis of absence of a correlation between any individual parameter and its corresponding model component (i. e. Factor). Accepting the zero hypothesis of independence in the working of the AaO mechanism infers that the phenomenon of a correlation in the population is more or less absent. The degree to which a correlation is absent, can be determined by the "effect size" index proposed by Cohen (1969). The larger this index the greater is the degree of an associative relationship between a parameter and some corresponding

step manifested in the processing. The value of this index is a dimensionless number and consequently free of the original measurement unit of the observable. In the present context, it is easily verified that the index is a standardisation of the difference between two standard scores.

Through the relation of this power estimate with the F-ratio, it is justifiable to avoid an equal treatment of Type I and Type II risks. Instead, the risk of a Type II error is set to zero. The probability of committing a Type II error is no serious mistake. With respect to the experimental hypothesis, taking a Type I risk, resulting in a false negative claim, is simply more serious. The significance of the produced evidence is twofold: In the generation of reproducible results, an essential step forward has been taken in demonstrating precision in the clock-like working of the AaO mechanism. The other advance concerns the demonstration of quasi independence of mass and length in keeping the pendulum swinging.

A second look at Table 1 of the Appendix may be taken with respect the absolute value of the zero hypothesis. The pairs of twins deviate more or less from zero. The deviations from absolute zero value, albeit not significant, constitutes a temporal as well as a spatial boundary condition. According to the second law of thermodynamics, the indexed deviations point toward greater structure at the macroscopic level. The minimum requirement for the operation of a configurational constraint seems to be two experimental units and a single constraint defined as pair and thus loss of a degree of freedom. It is as if the text of the twins constituted a soft moulded coupling of clockworks in pairs, which would be in line with von Holst's (1973) "magnetic effect".

Periodicity in Text Production.

Periodicity indicates an organised transfer of intentional potentials through the packaging of graphemes and strings of graphemes into blocks. Related to the city block metric as stated in Expression (10), a city block of proper length will capture natural occurring periodicity. If a token system fails to exhibit periodicity, then chaos reigns. The word chaos describes, according to its Latin definition, complete lack of form or any other systematic arrangement. It follows that Expression (12) is an important indicator whenever a particular invariant is postulated. To the extent that two or more independent texts are characterised by a common scope, they are in their rhythmic movements oscillating on the basis of a higher-order component. Because of the clock-like running of the investigated texts, their "magnetic effect" should be determinable by relating periodic time to grapheme production. The validation of a lawful relation between periodic timing and grapheme production follows the strategy outlined by Kugler and Turvey (1987, pp 205-250). By postulating a physical law as "'objective'" frame, they use the multiple regression model in the following form:

$$X_j = a_i (\text{physical law})^{ci} \qquad (12)$$

Expression (12) will be utilised with the purpose to derive the metrics of the co-ordinate spaces that embed lawful relations. A particular experimental unit (X_j) is viewed as a co-ordinate space. In analogy to the multiple regression model, its metric structure is defined by the deviations of intercept (a_i) and slope (c_i) from their approved magnitude. Kugler and Turvey interpret these indicators physically as strengths of certain scalars and vector potentials respectively.

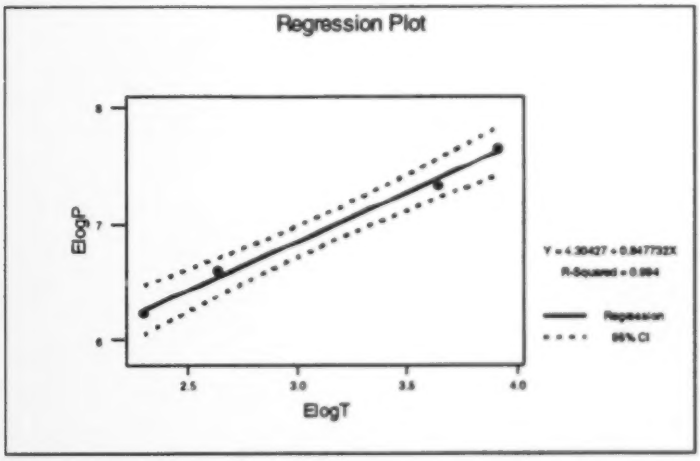
Expected relations between periodicity and the production of graphemes, relating to the formal postulate of invariants of structure, can be evaluated on the basis of the Equation (12). Similarities of the processes produce and consecutively maintain the operating constraints. Realisation of a verbal flow gradient is consequently a kinematic

abstraction of an underlying force field. Its form is indicated at the top of Table 4 of the Appendix.

At the kinetic level, all four token systems exhibit high similarity in their periodicity (P). Accordingly, (P) is an important factor in the production of total mass (T). A closer analysis of the equation shows that (R^2 = .991) and that the mass component has a scaling constant of proportionality (slope = 0.85) which is significant at ($p <$ .003). The constant by which mass productions in the co-ordinates of the mesh differs for all values is the intercept (= - 4.30) which is helpful in the mapping of the trajectory shown in Figure 1.

Figure 1.

Log_e Mesh: Natural Periods on Mass for four DZ



The trajectory of the depicted relation is linear and of the first order. When the conditions of linearity and first order relations are met, it can be stated that a lawful scaling relation exists. As shown in Figure 1, the scaling relation can be accounted for within the 95% limit of the confidence interval.

Thus far, two conclusions can be derived. From a "behaviour genetic" point of view, the DZ systems are very similar in their functioning. Farther, the minimal deviation from a straight line in the logarithmic co-ordinates implies inevitably a lawful relation as defined over the token systems. It follows that the four DZ twins comprise a distinct and useful evaluation of the significance of periodicity in text production. Its significance implies that mass relates to an elastic text potential. Moreover, the relation between paired individuals seems to inherit the magnetic effect. The twin-treatment implies the invariant tendency of non-holonomic constraint production. It is evident in Figure 1, that these constraints are operating during text production.

The other component of import in the scaling is length as measured in Blocks (B). The blocks are involved in the nesting of textual transformations. Thus, studying length in the same way as mass is enforced. It is assumed that a lawful basis exists and that the periods in text writing relate to the size of blocks. The hypothesis is that there is an invariant relation that holds independent of changes in speed and style of writing. Table 5 of the Appendix gives the related statistics and Figure 2 depicts the trajectory.

Figure 2.

Log, Mesh: Natural Periods on Length for four DZ

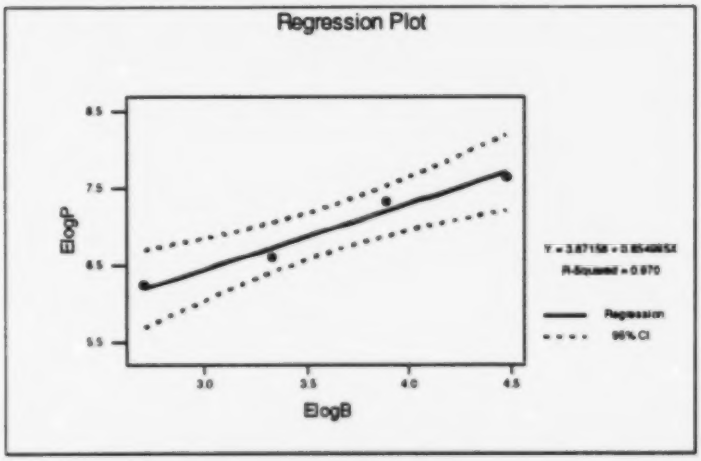


Figure 2 shows a trajectory that depicts the first order relation between naturally occurring periods and the increments in text production. The way in which the natural periods change during textual growth is determined by (R^2 = .96). Thus a significant straight line relates periods to length of a text. The scaling constant with a slope (.86) is significant at ($p < .015$), which means its departure from unity is due to variations in the co-ordinate space of the token systems. The same reasoning applies to the intercept (- 3.87) which is significant at ($p < .010$).

As can be read from the plot, all four systems oscillate around the straight line. The slopes of the lines closely approximate unity. It is evident that a linear relation exists between naturally occurring periods and text mass as well as length of text. This demonstrates that the "scaling law" for timing textual movements is structurally stable across the token systems.

All undertaken macro measures are aimed at a study of the relation between production quantities and the factors governing text production. What has been demonstrated is the existence of variations between the volumes of production (T). Farther, it is demonstrated that this variation is independent of the structure relations between the participating components as well as of components (MLT) themselves. The variations must be due to variations in the co-ordinate spaces. This hypothesis is tested on the basis of Tables 6 and 7 of the Appendix and the trajectories are shown in the Figures 3 and 4. Both Tables (6, 7) indicate non-linearity with respect to the identification of the individually defined co-ordinate spaces. Concerning the displacements and the stability in the auto-oscillatory activity, twin number three differs both from its fellow member and from the other twins. This deviation is evident in Figure 3 and refers to the twin's activity potential. In Figure 4, the relation refers to the twin's capacity.

In the respective geometric setting insignificant linearity implies departure from a straight line. This is indicative of non-uniformity. On the basis of non-linearity in the performance of the twins, it is demonstrable that different invariant relations are embedded in different geometric settings. In these settings, space and time metrics vary as a function of location of lawfulness. The two pair of twins have produced only insignificant differences. Evidently, on the kinetic level they do not differ in scale. Though in the case of the first Twin of the fourth pair (Twin 3) a slight deviation from the

straight line is noticeable in the Figures 3 and 4. Therefore, at the kinetic level each twin can be considered similar to any other because their writing-rewriting mechanism works in very similar fashion and they seem to be influenced by the same kind of reactive forces. It follows that each individual twin provides a unique physical context for the expression of physical law.

Figure 3.

Twins on the Moment of Textual Flow

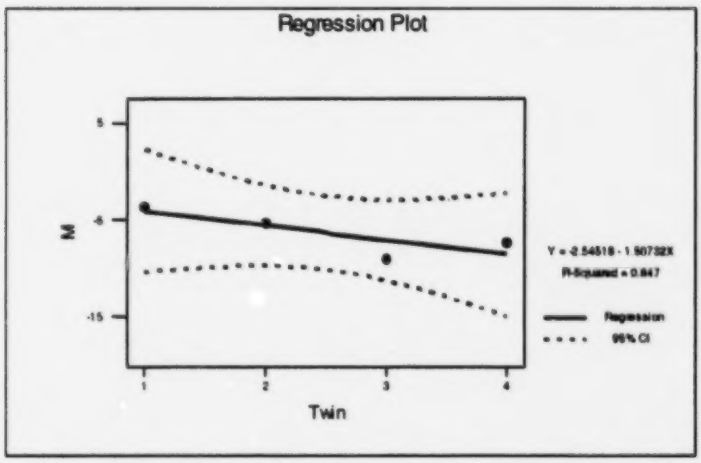
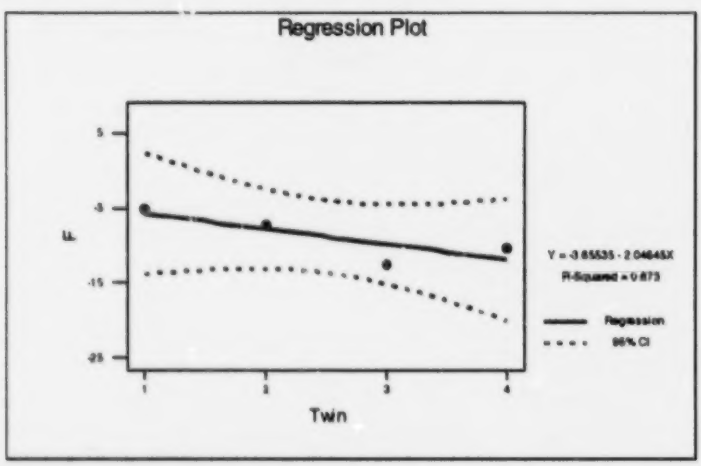


Figure 4.

Twins on the Force of the Textual Flow



Kinematic Patterning

This section is concerned with an analysis of kinematic patterning and the information carried by these patterns directs the analysis toward the scalar quantities that shape the characteristics of text building. In the development of a bio-physical theory of text processing, the introduction of textual agents as operators is linked to the existence of levels of intention. Motor actions of the text producer, even when directed

strongly and rigidly by language rules and regulations, have to be regarded as intentional. In the process of text production textual objectives become charged through the coupling of certain agents with particular objectives. What is significant for the continued analysis is the kinematic patterning in relation to textual movements and the geometric properties, resulting from these movements. Thus the focus is on the distribution of charged objectives throughout text production.

An important task, therefore, is to study the regularities in movement at which each twin system settles. This study is oriented toward the translation of similarity into non-material flows. When these flows produce stable and reliable adiabatic trajectories, their topological form can be reproduced as shown, for example in Figure 5.

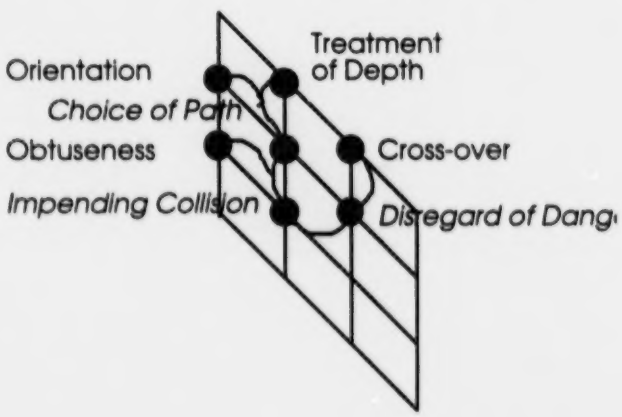
Because geometric form carries information abstracted from a text, this kind of form has been analysed and described within a *holistic* approach in B. Bierschenk (1996). In the discussion of geometric form as carrier of potential information, the strategy in the present analysis goes a step further. A potential indicates topologically the complexity of the information in a particular texture. Studying this information in an evolutionary perspective means studying a topological layout.

The layout of a surface is given attention to at the first terminal state which is "Treatment of Depth". The surface is fundamental to the ecological definition of depth. The child put down on a surface consisting of a table top of glass is confronted with two conditions: a shallow side and a deep side. When the process transits the state of "Orientation", the perception of places of a simulated environment comes into view.

These places merge into adjacent places. To the extent that the child is moving from one place to another, the *"Choice of Path"* can be observed. However, the perspective appearance of the two sides seems to have produced "Obtuseness". It means that the sides are indistinctly perceived. This tendency of being indistinctly aware of the differences means that perception of the environment and co-perception of one-self in that environment are complementary. Unaware of what-is-behind and of the togetherness of the far side and the near side by necessity leads to an *"Impending Collision"*. Controlling one's locomotion under these circumstances requires the discovery of the occluding edge of the defined cliff. Though the following step through the state of "Cross-over" is a radical departure from this requirement. Needed ecologically significant information has not been picked-up, which means that the observer's perceptual system has failed to extract the invariant. Because visual lay out perception and visual

Figure 5.

Holotop of Twin 31. Male Figure Component



kinesthesis are complementary, the final outcome is *"Disregard of Danger"*. To perceive the cliff as defined over the two sides, means not only the detection of a layout, but also the detection of an affordance. It follows that the affordance of the cliff relative to the observer is of a negative kind and has passed undetected.

The specification of the first twin of pair no. 3 continues with an analysis of the corresponding ESS-values given in Table 1. The point of reference is the intersection (x_3,y_2) which is specified by a disregard of danger. It is also the final outcome of the involved transformational process. Thus, the top is supported by the third dimension of the underlying state space as shown by the response surface attached to Table 1.

Table 1.

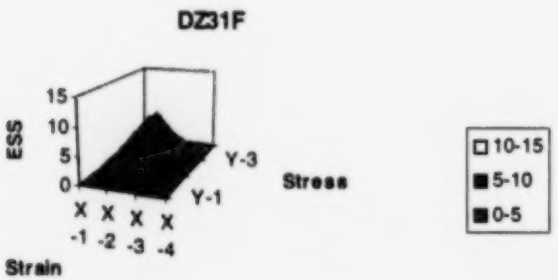
Specification of the ESS-values of the Terminals and Attractors of DZ 31 F

DZ31F	X-1	X-2	X-3	X-4
Y-1	•	4.00	0.000	•
Y-2	0.00	*5.71*	*10.77*	•
Y-3	0.00	*7.56*	•	•
Y-4	•	•	•	•

A second supporting dimension (x_2) concerns a gradient. Viewed qualitatively, two state attractors above (ESS = 5.00) define the gradient's inclination which slants into a terminal state that is below this value. The intentional content determining the path of locomotion is represented by this dimension. A beginning is made in the choice of a path, but the possible ways in which the actual locomotor displacements may end is open ended and consequently unspecified. It follows that dimension (x_2) represents a possible but unexplored change in perspective and consequently a conceptual change as shown in the Holophor of Figure 6.

Figure 6.

Holophor of the Figure Component

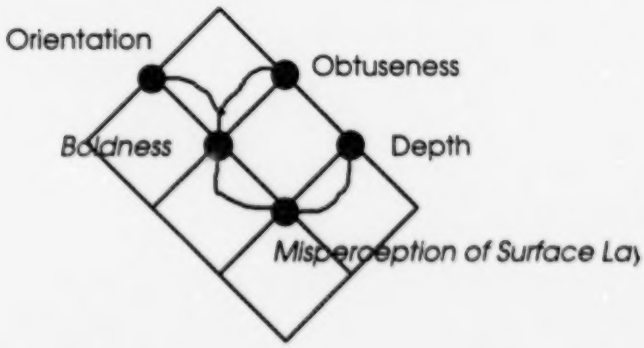


Twin 31. Male Ground Component

Whenever the information in the Ground component is present, it constitutes essential support of the Figure component. In following the same procedure as in the previous case it is applied to the state space of the Ground component. Figure 7 shows a geometric form that is defined topologically by two singularities. It is evident that the inability of this twin relates to perceiving correctly the behavioural import, dominating the profile. Thus, the dimension (x_3) of the state space supports the global singularity of this configuration.

Figure 7.

Holotop of Twin 31. Male Ground Component



The initial state in the Ground is "Obtuseness" which indicates that the acute change in the form of its patterned surface is indistinctly perceived. By passing the state of "Orientation", the adjacent checker-squares of the patterns are passed over without daring. This process results in *"Boldness"*. It is the outcome of a pick-up of misinformation for the affordance of the environment. Because the affordance of a collision was not specified, "Depth" as a feature of the surface layout is not perceived. It follows that *"Misperception of Surface Layout"* means that the immense of collision has passed unnoticed. Further inspection of Table 2 together with Figure 8 shows that a shelf is resulting from the relation between dimension x_2 and x_3. The attractor state indicates simplicity. Thus, impertinence effects the conceptualisation of the affordance of the visual cliff. Overlooked significance of ecological information, means insensitivity to the import of surface variation, and implies that behavioural constraints are misconceived.

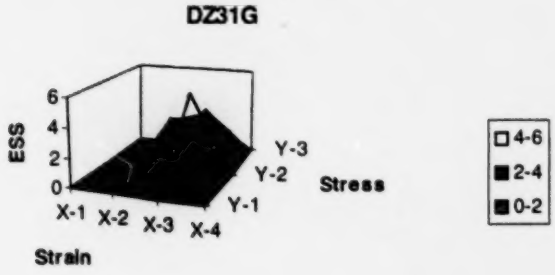
Table 2.

Specification of the ESS-values of the Terminals and Attractors of DZ 31 G

DZ31G	X-1	X-2	X-3	X-4
Y-1	*	2.00	0.00	*
Y-2	0.00	*3.60*	*5.43*	*
Y-3	*	*	*	*

Figure 8.

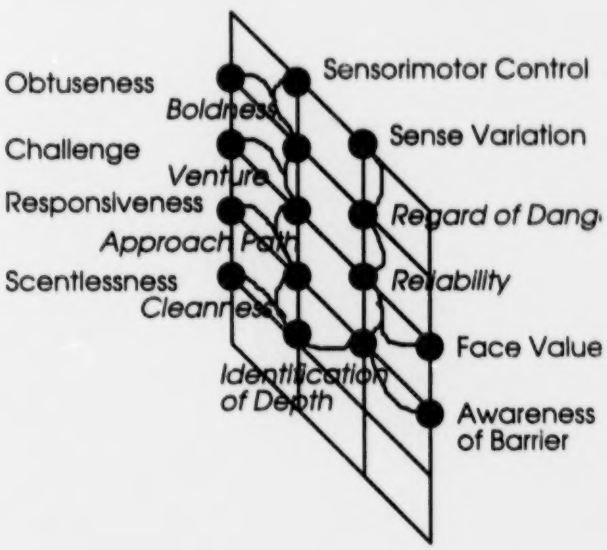
Holophor of the Ground Component



The second member (32) of this pair has produced a Figure-component only. Figure 9 shows its topological layout. In the visual cliff experiments, the optical information is contradictory to the haptic information. The terminal state "Sensory-motor Control" refers to the conception of a need of mechanical contact with the floor. Feeling the surface means pick-up of tactual information. By passing through the state of "Obtuseness" required optical information seems to be indistinctly perceived. Feeling the surface and seeing its patterning as indifferent lead to *"Boldness"*. This state implies that no signs of discomfort are displayed. In transiting through the state of

Figure 9.

Holotop of Twin 32. Male Figure Component



"Challenge" the child on the floor is called to engage into movement. The resulting *"Venture"* suggests an undertaking that is dangerous or at least of doubtful outcome. By passing the state of "Responsiveness" his reactions to the patterning of the surface are producing an *"Approach Path"*. This path determines the child's nearing to the boundary where the surface of support ends. The state of "Scentlessness" suggests the

absence of any hint to something imminent. What is identified through this transformational step is *"Cleanness"* of the environment. Free from perceptual disturbances, an "Awareness of Barrier" points toward an ecologically significant feature in the terrain that may prevent the child from locomotion. When a barrier becomes associated with the face of a cliff, *"Identification of Depth"* is the expected result. The face value of the cliff is concentrated to its brink. Its "Reliability" in preventing locomotion is determined by its affordance. Through "Sense Variation" the child is testing the surface through feeling as well as seeing. It follows that "Reliability" in information pick-up is suggestive of depth perception. Perception of depth means the detection of a negative affordance for locomotion. Thus, it is a property of the environment taken with reference to the observer's *"Regard to Danger"*. Control of one's locomotion involves the edge of danger and a gradient of danger as well. Their close consideration provides for a measurable approach and the inference of the perception of depth.

That it carries a different type of information is shown in Table 3 and Figure 10. Geometric form changes toward greater differentiation. The scalar value relating the root of the information structure quantitatively to the underlying state space appears at the intersection (x_3y_2). This position indicates this twin's successful conceptualisation of danger. Approximately of the same quantity is the emerging singularity at intersection (x_3y_3).

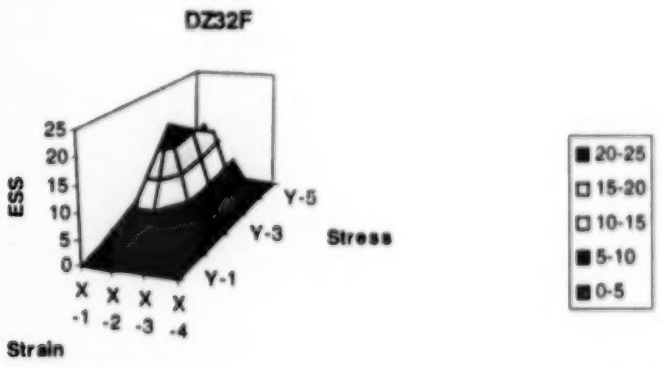
Table 3.

Specification of the ESS-values of the Terminals and Attractors of DZ 32 F

DZ32F	X-1	X-2	X-3	X-4
Y-1	*	08.00	00.67	*
Y-2	0.00	*09.82*	*24.17*	*
Y-3	0.00	*11.69*	*20.38*	0.50
Y-4	0.00	*13.60*	*17.47*	0.00
Y-5	0.00	*15.53*	*	*
Y-6	*	*	*	*

Figure 10.

Holophor of the Figure Component



Information concentrated in this position specifies a capacity of paying attention to danger. Below this plateau, a cognitive dimension takes shape. This dimension

concerns the actuality in the description of a gradient approximating danger. Finally, the hazard associated with the conceived approach path is indicated at a second level and supported by dimension (x_2).

The initial terminal state of the Holotop of Figure 11 has been identified with "Conscientious". The critical value of this terminus constrains the system toward the moral and ethical quality of the mind. At this terminal, the mental structure serves to inhibit harmful behaviour by producing feelings of guilt. The physical constraint that hinders harmful behaviour is given by the state "Barrier", that transforms the process into a state attractor. At the singularity *"Pondering"* an adiabatic trajectory comes into existence.

Figure 11.

Holotop of Twin 41. Female Figure

This new attractor state constitutes the limit at which weighing mentally or giving careful consideration to risks is in focus. It involves the immediate interaction with one's surrounding. The anchorage of thermodynamic processes are reflected in the higher-order components that are independent of the mechanical processes at the

kinetic level. The next step implies that the process transits through the terminal state "Security". At this point, it is the individual that takes measures to protect its effectiveness. The outcome is a limit at which "Assertiveness" directs expressive behaviour. It reflects a concern with a forceful and affirmative expression of one's inclination. "Mistakenness" marks the use of improper information or operations. It follows that positive and affirmative actions transform into *"Disappointment"*. Action degrades into frustration.

In its successive transition the process incorporates sensitive perception through the state of "Apprehension". By seizing and capturing the dread laid out, felt uneasiness transforms into *"Attunement"*. Through this transformational step, self-correction is achieved. By passing the state of "Safety", the process reaches a point of freedom from accidental injury. This transitional step generates the terminus *"Affirmation"* which gives firmness to the reach position. Showing carefulness in one's approach of a dangerous place is implied by the state "Cautious Approach". Involved is a kind of forethought in avoiding danger. The outcome is *"Appraisement"*. Thus, the trajectory has developed into an indication of an evaluative attitude toward the size of the obstacle on the approach path. The following state extends this fashion in that the process enters "Circumspection" which is constraining perception to close attention to the given circumstances. The result is specified in the singularity *"Determination of Boundary"*. It concerns the identification of a demarcating limit in the given environment. An ability to deal effectively with the identified limit is implied by the state "Resourcefulness". To be readily able to act effectively leads immediately to terminus *"Acuity"*. This state attractor provides the sharpness needed.

Through care and preparation in advance, it is possible to exercise situational control. This is the meaning of constraining the process in passing through "Providence". As a result *"Mastery"* emerges. At this point the status of a master is reached, who is fully in command of the task of discriminating between various qualities of the surface lay-out. The necessary mental processes are anticipated by the state of "Reasoning". It means that inferences are drawn from observations within the bonds of common sense. These inferences relate to the limits of locomotion. The outcome of this transitional step is a *"Principled Action"*. Acting on a principium, especially one that is basic, leads to expected or "good" behaviour. To locate and place this behaviour into a particular relation between organism and environment is to align the observer's position to his self-reference. "Orientation" is the state that marks the impact of this constraint on the evolving trajectory. At the singularity *"Orderliness"* it becomes evident that a methodological and systematic arrangement is required for the demonstration of the operating principle.

What is conceived and put forward by the arrangement is conserved in the "Proposal" state. What is "offered" consequently leads to *"Determination of Strategy"*. Essential for the developing trajectory is the manifestation of a plan. This plan may have resulted from practice. Through the "Degree of self-awareness", the individual's limitations in information pick-up governs its *"Style of Conduct"*. This style determines one's ability to direct one's own course of action and to manage behavioural self-control. Its sensitive dependency on ecological information implies that the state of "Misinformation" by necessity leads to *"Misguidance"*. Information processing results in a false decision concerning the direction of the course to be taken.

In the intersection (x_4y_9) arises a moment where the affordance of the surface layout can be misperceived, and the process shows a hysteresis. Through a sudden jump into a new path "Reassurance" enters into the behaviour space. The surface seems to have caused a uncomfortable feeling, because of the transparent floor through which the ground can be seen far below. To restore confidence means the assurance of

a persisting environmental layout. When this state becomes transformed by passing "Advantage" a factor enters into the path that is favourable to successful resistance to a sudden change. Thus *"Stability"* is the final outcome of the second path.

When in intersection (x_3y_7) the second path crosses the first one, "Monitoring" emerges as a singularity that is deeper embedded in the mental structure as any of the preceding singularities. It reflects the synthesis of confounded perception and attention processes. The experimenters used the mother of the child as lure. Her role on the present path is conceptualised as one that keeps watching over the child's actions on the cliff. This conception gets an extended import through the state of "Training". To coach in and accustom the child to the right mode of behaviour is thought of as a way toward gaining *"Skillfulness"* in performance. The final singularity of the third path manifests a focus on a mental preparation for the discrimination task.

A new jump into a fourth path introduces the state of "Testing". It concerns the determination of physical reactions by which the perception of substance as well as its absence may be deduced or its affordance ascertained. By passing the state of "Prevention" the process of falling off is kept from happening. It follows that the outcome of this measure transforms into an arrangement that generates test conditions approximating an actual cliff. Thus *"Simulation"* means the generation of operational conditions that conform to reality. "Challenging" the testee in an environment that simulates the appearance of a "real cliff" requires *"Abstract Thinking"*. A conventional perspective emerges. Perceiving a cliff is associated with learning to see the third space dimension.

When at (x_3y_3) the fourth path crosses the third, the state of *"Pure Reason"* manifests itself on the same dimension as *"Monitoring"*. Embedded in the mental structure seems to be a conception of a theoretical rather than an empirical understanding and articulation. Therefore, "Adventure" transforms the perceived course of events into a *"Systematic Accomplishment"* where the state of "Non-crossing" of the cliff turns the perceptual process into a *"Deduction of Danger"*.

Table 4.

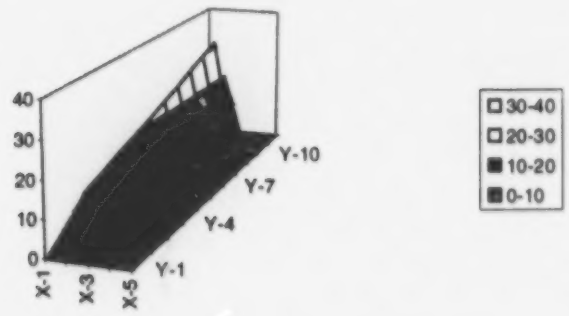
Specification of the ESS-values of the Terminals and Attractors of DZ 41 F

DZ41F	X-1	X-2	X-3	X-4	X-5
Y-1	•	12.00	00.80	•	•
Y-2	0.00	*13.87*	*72.08*	*66.26*	0.00
Y-3	0.00	*15.76*	*61.44*	*05.25*	0.00
Y-4	0.00	*17.68*	•	*02.50*	0.00
Y-5	0.00	*19.62*	•	•	0.50
Y-6	0.00	*21.57*	•	*51.77*	0.50
Y-7	0.00	*23.52*	*47.92*	*01.75*	0.00
Y-8	0.00	*25.48*	•	•	0.00
Y-9	0.00	*27.45*	•	*43.02*	0.50
Y-10	0.00	*29.42*	•	*40.10*	0.00
Y-11	0.00	*31.39*	*34.28*	*37.18*	0.00
Y-12	0.00	•	00.00	•	•

Compared to the previous topologies, Table 4 and Figure 12 show a much more compact topology. It implies an important difference in conduct to the visual cliff pictures. The root, found at the intersection (x_4y_3), indicates that this twin's conduct of approach concerns a deduction of danger.

Figure 12.

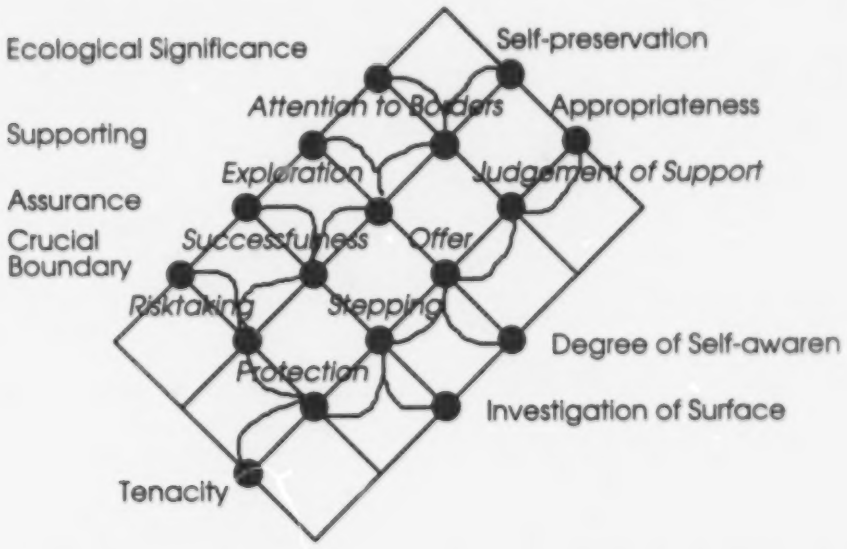
Holophor of the Figure Component



Together with the information concentrated at the intersection (x_3y_2), the peak has emerged and involves a deduction of danger which is a systematic accomplishment and consequently an important element in the strategy of Twin 41. One level below this accomplishment arose a hysteresis. This means a downward slope of the curve. On the

Figure 13.

Twin 41. Female Ground



other hand, the curve is rising at the intersection (x_3y_7). In this position it becomes obvious that monitoring is the preferred approach to the visual cliff. The final indication of this level is found at the intersection (x_3y_{11}) which is the other important point of orientation underlying the dimensionality of the state space. A third layer can be observed at a still lower level. The underlying dimension of the state space is (x_2) and

carries principled action as essential property. In all three dimensions play the capacity of thinking abstractly a profound role.

The terminal state, initiating the ground to the figure just outlined, is "Self-preservation". Thus, the protection of one-self from harm or destruction is in focus of the Holotop of Figure 13.

A transformation of this state thorough "Ecological Significance" means that optical information is provided instead of imposing optical stimulation. This step leads to the first singularity of the path in the ground: *"Attention to Borders"*. It is constitutive of the environment, because an environment is made up of places that can be named, but usually they have neither sharp profiles nor are they transparent. Attention paid to borders means attention paid to a cut edge. By passing through the state of "Supporting", this cutting edge is partly defined by a textured surface terminating abruptly. This part of the surface supports *"Exploration"* and consequently the development of a path. This path must afford "footing". The general capacity to step over openings in a surface without falling gives confidence to locomotion through an environment. "Assurance" transforms this movement into *"Successfulness"*. This terminus relates to the near surface which is safe. By arriving at the "Crucial Boundary", danger becomes a reality. The resulting "Risk-taking" involves the control of locomotion at the edge of danger as well as on a developing gradient of danger. The closer the child is to the brink the greater is the danger.

Holding or tending to hold one-self on the safe part of the cliff is implied by the state of "Tenacity". It follows that the approach path guarantees safe-conduct to the locomoting infant. This is marked by *"Protection"*. Nevertheless, a systematic examination is imposed by "Investigation of the Surface". This constraint governs the process toward a *"Stepping"* performance. It is dependent partly on information about one-self and partly on information about the environment. This twofold dependency makes the "Degree of Self-awareness" inseparable, because perception and proprioception are complementary in becoming aware of an *"Offer"*. "Appropriateness" of the provided optical information specifies one's *"Judgement of Support"*. If the cliff is a drop-off that is dangerous or only a step depends on one's self-reference.

By the perceptual activity of Twin 41, information pertaining to the Ground component has been extracted. The scalar quantity, relating this information to the underlying state space, is specified in Table 5 and Figure 14. Relative to the previously discussed Ground component, the present perceptual approach takes its departure in an intellectual function. By making reasonable good sense out of the pictured episode,

Table 5.

Specification of the ESS-values of the Terminals and Attractors of DZ 41 G

DZ41G	X-1	X-2	X-3	X-4
Y-1	*	09.00	00.00	*
Y-2	0.00	10.83	24.38	*
Y-3	0.00	12.71	22.42	0.00
Y-4	0.00	14.62	20.45	0.00
Y-5	0.00	16.56	18.50	*
Y-6	*	*	00.00	*

the function of judgement manifests itself in the final singularity. Thus, the plateau of Figure 14 contains a discriminating appraisal of what is offered. The second dimension refers to that what "cuts" the surface into parts and constitutes a risky place. On the

same dimension, but farther below that level, successful attention paying supports the exploration of the cutting edge.

Figure 14.

Holophor of the Ground Component

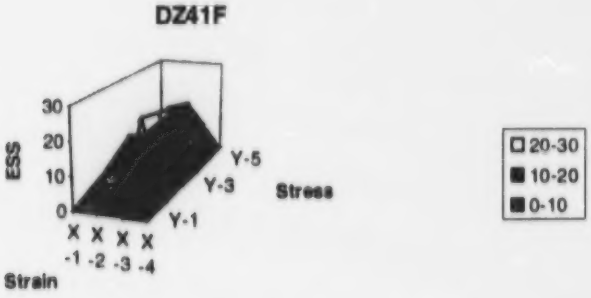
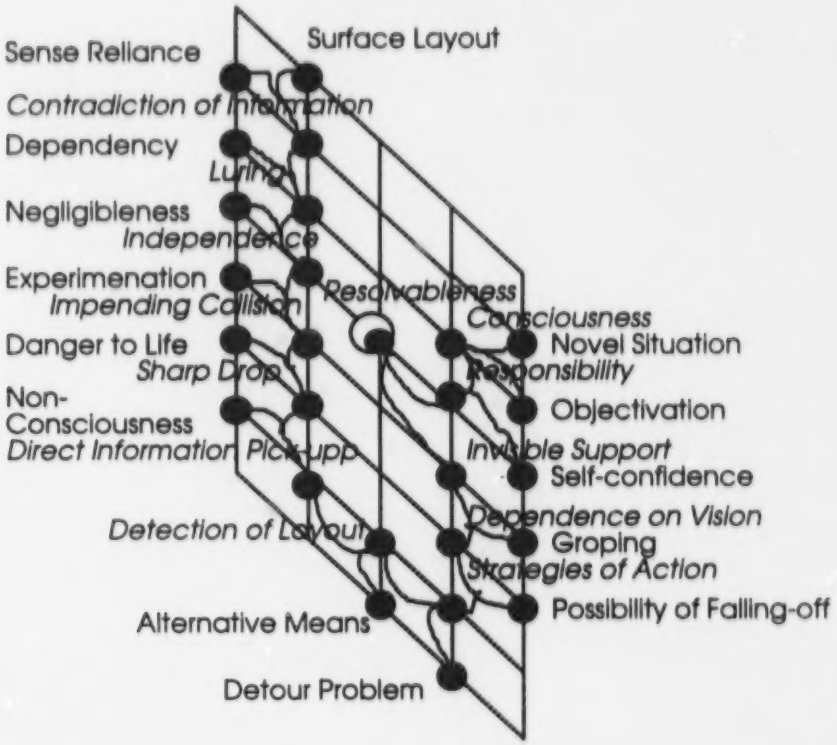


Figure 15.

Holotop of Twin 42. Female Figure



Intersection (x_2y_1) in Figure 15 is occupied by a the terminal state that concerns "Surface Layout" of the visual cliff. It separates the medium from the substances of an environment. Moreover, it has a certain layout. Characteristic properties such as its

texture influence the observers "Sense of Reliance" differently. Sensitivity to the make-up of the texture results in *"Contradictions of Information"*. This is the first singularity of the path and indicates that locomotion becomes questionable. "Dependency" of locomotion on some attracting source are *"Luring"* the testee into action. However, the attracting potential implies "Negligibleness" relative to this source of attraction. It follows that *"Independence"* of locomotion is the result of this transformational step.

Through "Experimentation" the appearance of the "Surface Layout" is changing. The designed provocation is likely to produce an *"Impending Collision"* with a distant ground. This is indicated by the terminal state "Danger to Life" and means that the slope of the terrain forms a *"Sharp Drop"*. From a perceptual point of view, this singularity is associated with risk-taking. Though "Non-consciousness" in approaching the drop seems to be indicative of a *"Direct Information Pick-up"*. In essence, this means that the limits of approach have to be detected. Through "Alternative Means", it is possible to grasp the size of the distance between observer and ground in that *"Detection of Layout"* has been manifested. The following step gives expression to a "Detour Problem". Insofar as possible paths of locomotion afford alternative *"Strategies of Action"* , the drop can be circumvented. To explore alternatives requires that the "Surface Layout" has a persisting and substantial part. What can be done namely is constraint by the "Possibility of falling off". It follows that the possible ways of locomoting in the environment and the environment itself go together inseparably. The Gibsonian hypothesis of information in ambient light is crucial in the transformational step toward the cliff which implies a *"Dependence on Vision"*. The experimental modification of the "Surface Layout" supports this condition. But it supports also another condition, that is, the feeling of support only. "Groping" means contact with the completely transparent part of the surface which gives *"Invisible Support"* to the locomotion. At this point (x_4y_5) the first path has reached its peak.

A second path begins to form at (x_5y_2). In a most fundamental sense, the visual cliff constitutes a "Novel Situation". An infant put on a large sheet of glass always feels the surface supporting his feet, except when falling off. Moreover, when supported, the child can always see the surface. Thus, "Objectivation" at (x_5y_3) carries the ecologically significant information and implies an experimental modification of the floor. In the case where the floor carries contradictory or conflicting information, the presence of *"Consciousness"* can be tested only through an appropriate experimental set-up. The conceived "Self-confidence" of the child determines its *"Responsibility"* and the highest point of the second path. In that the second path transforms the first at (x_3y_4), responsibility in the presence of *"Invisible Support"* , becomes shallow. The final singularity "Resolvableness" takes note of the intention of the text producer. But from the orientational point of view, it does not take into account that perception always means co-perception of one's self. It follows that a solution path to the problem of depth perception has not been achieved.

The fourth twin has produced a text that has given rise to the magnitudes presented in Table 6 and the topological configuration presented in Figure 16. In the foreground of Figure 16 at the left hand side appears a stratum that concentrates the information concerning the cutting edge of the experimental set-up. At the next higher level materialises a half-circled stratum that is strained over all x-dimensions. Its stress comes to rest in the dimension (y_7). This dimension contains cognition oriented information. All attractors concern the perceptual mechanism and its import for action formation. The third level has its base in the intersection (x_3y_4), whose attractor concerns the transparency of the surface. Finally, it is not immediately clear that the global state attractor is to be found in a position at intersection (x_3y_3). The deformation of the response surface shows in the foreground a just noticeable fold, related to a child's

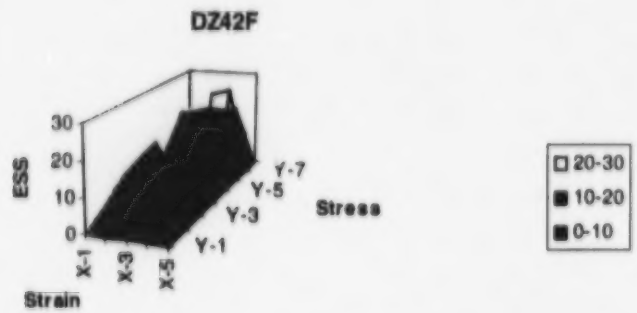
Table 6.

Specification of the ESS-values of the Terminals and Attractors of DZ 42 F

DZ42F	X-1	X-2	X-3	X-4	X-5
Y-1	*	11.00	*	*	*
Y-2	0.00	12.86	*	*	0.00
Y-3	0.00	14.75	*	01.33	0.00
Y-4	0.00	16.67	41.60	04.86	0.75
Y-5	0.00	18.60	*	32.24	0.00
Y-6	0.00	20.55	*	29.37	0.50
Y-7	0.00	22.50	24.46	26.43	*
Y-8	*	*	00.00	00.00	*

Figure 16.

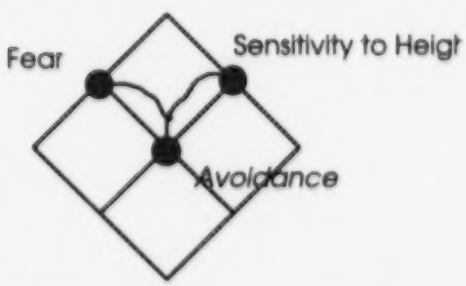
Holophor of the Figure Component



autonomous and immediate distinction of surface variations. From there a line is trekking to the top. It is here where the conceptual process turns into simplification. Where the steepest fall can be observed, the tendency of ignoring the significance of the depth factor has formed finally into a singular state. Moreover, the absence of the Ground component underlines this naïve conceptual approach. No information has materialised that helps anchoring the presented behaviour space (Figure 16) in reality. On the other hand, Figure 17 makes the behaviour space of the Goal component approachable.

Figure 17.

Holotop of Twin 42. Female Goal Component



In agreement with the wiew that "Sensitivity to Height" is a natural clue to danger, the nature of "Fear " ia an integartive part of the experimental set-up. Thus it is inferred that a "natural" design should have the capacity of manifesting *"Avoidance"*. The observer has been sensitive to the crucial problem of measurement and perceived the Goal of the experiment. The purpose of incorporating the avoidance paradigm into the studies of visual perception has been to generate a basis for inference concerning the perception of depth. The ESS-values of this solution space are presented in Table 7 and the corresponding response surface is given in Figure 18.

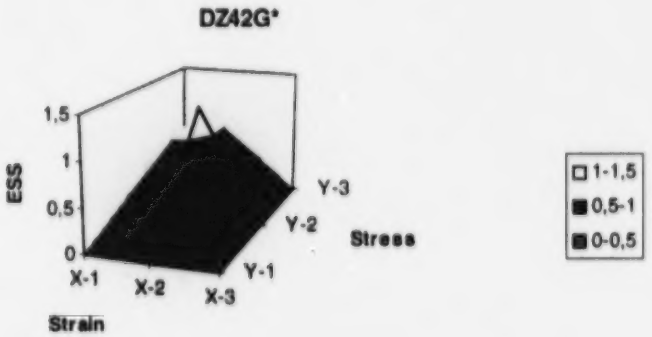
Table 7.

*Specification of the ESS-values of the Terminals and Attractors of DZ 42 G**

DZ42G*	X-1	X-2	X-3
Y-1	*	0.00	*
Y-2	0.00	1.33	*
Y-3	*	*	*

Figure 18.

Holophor of the Goal Component



This space is very small. It is in fact the smallest possible set of states that can contain a singular state. Its singular state is identified with an attractor that concentrates on sensitivity to height. It is evidently important for this twin to state the goal of the experimental set-up though adhering to an easy solution.

It is important to note that the manifested Goal component is in harmony with the configuration of Figure 15. The goal does not denote any behavioural fulfilment of the child's intention. Conceptualisation of a behavioural solution to the crucial problem of optical information processing seems to be beyond the horizon. Any comprehensive perception of the problem by necessity must include an idea of how to measure depth perception.

Discussion

In text building behaviour a dynamic regime generates and assembles very large numbers of degrees of freedom into clock-like pendular movements that shape a functional unity. Together with previous studies, the present analysis has shown that the Scanator methodology keeps track of the involved unitising activities. The twin studies

carried out confirm the existence of a very precise functioning writing-rewriting mechanism. Based on a number of rigorous measures performed on the kinetic level, it has been demonstrated that the production and joining of graphemes and strings of graphemes is independent of any particular text producer.

The four language systems of the present study have produced six topological profiles whose response surfaces are more or less similar. For example, multi-variation in the profiles of the third pair of twins deviates from the fourth. The last one has produced more variation and consequently extracted a larger number of lawful regularities. Considered individually, each text producer has his own unique characteristics. From a biophysical point of view, each one can be classified according to the number of realised components. The first twin of the third pair has contributed with a Figure as well as a Ground. On the other hand, when classified with respect to the number and layout of singular states, the second twin has been more proficient. When considered as a pair, the twins show a certain complementarity. While both are showing a behavioural inclination, they deviate in a complementary fashion from each other's perspective.

The information carried by the picture series is always potential information. Whether and to what degree the perceptual mechanism picks up this information successfully, depends on the way in which potentially available information has registered. It is assumed that perceptual sensitivity to fine grained information is biologically based. But information pick up may also depend on paying attention to objects or events. Moreover, a particular level of practice may have an influence on the perceptual outcome. Since the layout in itself is ambiguous, possible misperception is a reasonable outcome. However, the first twin has been able to perceive the compactness of structure and to extract the cliff, but disembarks on the wrong conclusion.

In contrast, the other twin has successfully picked up the child's fear of height and conceptualised it as regard to danger. In this case the perceived difference has been conceptualised as depth. Thus, the negative affordance of the cliff exists and makes possible the control of the behaviour. But the degree to which it is picked up depends on the perspective of the perceiver. In addition, the consequences of a negative affordance has been conceptualised in a double and complementary sense. Together the twins unite the possible experimental outcomes. What makes the difference is their degree of consciousness.

The other pair of twins exhibits the same general pattern of similarities and dissimilarities. A comparison of their topological configurations shows a profound change in concepts and conceptual relationship. The second pair has evidently developed an intellectual style of approach. The first twin of this pair is studied by inspecting the states and arrangement of singularities. Thereby, it becomes obvious that the gradient of the cliff is processed in order to deduce the instrumental aspect of the simulator. Four topical changes have emerged in the accentuation of its properties and their control of appropriate behavioural achievement. An "error-free" and consequently informed approach links up with the control of how knowledge of the environment is acquired.

The other twin of the second pair is also intentionally determined to follow a logical approach. But the outcome is at least vague with respect to its behavioural orientation. Gibson's theory of information pick up is founded on the axiom of immediate perception of environmental structure. Starting from variance and invariance considerations, ecological perception takes environmental reflectancies into account. Gibson (1979. p. 258) asserts:

"... the extracting and abstracting of invariants are what happens in both perceiving and knowing. To perceive the environment and to conceive it are different in degree but not in kind".

In testing this assumption, the pick up of environmental affordance, operationally defined over the two sides of the cliff, shows an incongruent result. From the perceptual point of view, the event structure has given rise to comparable states and singularities. But from a conceptual point of view the concepts and relations between concepts show large qualitative differences. The last twin makes evident that differences in quality imply profound differences with respect to the judgement of consequences, i.e., the style of approach.

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Skjöde, E. (Ed.) (1996). Nya rön. Det senaste forskningsresultaten och upptäckterna från hela världen. Nu kan vi se inbillade röster i hjärnan. En del schizofrena har kanske defekta nervförbindelser: Psykiatri (New observations. The latest research results and discoveries from the whole world. Now we can see imaged voices in the brain. A proportion of schizophrenics perhaps have defective nerve connections). *Illustrerad Vetenskap, 5*, p. 19.

Appendix

Text 1.

Twin 31. Male text

För ett antal år sedan gjordes ett experiment, där man testade om mycket små barn hade djupseende.
Modern släppte ut barnet på en stor rutig yta och lockade det till sig från andra sidan. Mellan dem låg det istället för den rutiga ytan en glasskiva med en fördjupning under. Bottnen på denna var också rutig så att barnet inte skulle se någon skillnad på färg och form. När barnet krupit fram till kanten där glasskivan började, tvekade det, men efter att ha känt efter så vågade det sig slutligen över.

Text 2.

Twin 32. Male Text

Jag tror att det är en undersökning som går ut på att testa ett litet barns olika sinnen. Barnet placeras på ett rutigt bord med höga kanter. Därefter får barnet höra olika ljud och känna olika lukter samtidigt som en stor mängd forskare antecknar alla barnets reaktioner. Man testar även hur väl ett litet barn kan känna igen sin egen mamma, både när det gäller lukt och utseende och röst. Sen låter man ungen följa en ljuskägla som rör sig fram och tillbaka på sidan av bordet. Syftet är här att testa ett litet barns reaktioner när den bara ser ljus och varken kan känna någon lukt eller ta på någonting. Till slut testar man vad barnet skulle göra om det såg sin mor på andra sidan av ett farligt djup som det ej kan ta sig över.

Text 3.

Twin 41. Female text

1. Jag släpper mitt barn på ett rutigt golv. På golvet finns det upphöjningar, lister och tvära slut som barnet inte kan se direkt, utan måste känna sig fram för att upptäcka. Som vanligt är barnet glad och upphetsat inför nya saker och ler med hela ansiktet. Eftersom det litar på mig står jag bakom som stöd och för att förhindra olyckor. Det är viktigt att inte barnet blir rätt utan litar på sig själv.
2. Barnet ger sig ut på upptäcktsfärd. Det skyndar sig tillbaka till mig för att försäkra sig om att jag fortfarande är kvar och för att berätta att det mår bra. Jag vill lära mitt barn redan tidigt att inte ta allting för givet. Redan som liten ska det kunna använda sitt huvud och tänka kritiskt. Det man ser är inte alltid det rätta. Det rätta kan du bara ta reda på genom att själv bilda dig en uppfattning om saken i fråga.
3. Nu börjar barnet utforska sin miljö och ta reda på vad som finns för spännande att upptäcka. Inombords är det tryggt och glömmer snart att jag står och tittar på det. Barnet kommer fram till den kritiska gränsen där det gäller att vara försiktig. Med händer, ögon och hjärna känner, ser och tänker det sig för och efterhand kommer det på att det trygga golvet är borta och det finns bara luft nedanför. Genast börjar tankeverksamheten kasta fram ett förslag till att komma ner till det andra golvet.
4. Barnet vill naturligtvis fortsätta att se vad som finns nedanför avgrunden. Den har också upptäckt sin spegelbild och måste ta på den för att se om den är levande, kanske

en kamrat? Jag vill inte att mitt barn ska bli rädd för nya erfarenheter utan istället ta till sig dem och begrunda dem för att sedan dra nytta av dem vid senare tillfälle. Här har jag tränat mitt barn med ett vilseledande golv, men det kunde lika gärna varit en text eller dikt med ett dolt budskap eller varför inte ett tillfälle senare i livet där det gällde att fatta ett viktigt och avgörande beslut. Då kan det vara en fördel att ha ovanstående att luta sig tillbaka på. Erfarenheter som man får som spädbarn finns kvar resten av livet.

Text 4.

Twin 42. Female text

Ett litet barn utforskar ett badrumsgolv och träffar på olika upphöjningar, nedsänkningar och material av olika slag. Barnets mamma ser till så att inget farligt händer och iakttar samtidigt hur barnet reagerar på de olika formerna och ytorna. Golvet är rutigt och därför syns inte formförändringarna så tydligt. Krypande utforskar barnet sin omgivning med hjälp av sina händer och fötter. En glasskiva utgör ett hinder och det blir grundligt utforskat. Barnet har sitt huvud högt och därmed använder det inte så mycket sitt seende som hjälpmedel, till skillnad från vuxna.
Detta experiment handlar kanske om hur barn använder sina sinnen, vilket sinne som man som barn har mest nytta av. Mamman bevakar beskyddande sitt barn men barnet aktar sig noga för att falla. Det känner genast när det fasta underlaget övergår till avgrund och vänder. Mörker eller ljus hade förmodligen inte spelat någon roll.
Om man vill ta experimentet som något psykiskt experiment kan man tänka sig att det handlar om någon slags "personlighets-jagtest".
Då barnet ser sig som en individ skyddar det sig från faror som kan skada "jaget". Ett barn som inte hade varit medveten om sin person hade kanske krupit rakt ut i avgrunden. Det kan också röra sig om barnets förmåga att hantera okända situationer. Systematiskt försöker barnet att hitta nya utvägar. Kanske ett förstadium till att finna utvägar till kommande problem.
Barnet visar ingen skräck för höjd. Det är tryggt. Sådan känslor som höjdskräck kommer nog först sedan det blivit utsatt för något hemskt.

Table 1.

DZ Twins: Pairs of Opposite Sex

Source (Factor)	Wilks' Λ	Cohen's f	F	p
Mass				
Grapheme				
Twin	.86902	.3882	.151	.764
Pair	.08462	3.2890	10.818	.188
Spatium				
Twin	.81385	.4783	.229	.716
Pair	.17039	2.2066	4.869	.271
Periods				
Marker				
SM				
Twin	.71176	.6299	.405	.639
Pair	.08990	3.1817	10.124	.194
CM				
Twin	.03846	5.0000	25.000	.126
Pair	.03846	5.0000	25.000	.126
TSM				
Twin	.96154	.6324	.040	.874
Pair	.02887	.7998	33.640	.109
Length				
Block				
Twin	.80000	.5000	.250	.705
Pair	.23432	1.8077	3.268	.322
Linkage				
A-dummy				
Twin	.70159	.6522	.425	.632
Pair	.37019	1.3043	1.701	.416
O-dummy				
Twin	.53444	.9333	.817	.522
Pair	.31735	1.4666	2.151	.381
Momentum				
Viscosity				
Twin	1.00000	.0000	.000	1.000
Pair	.19137	2.0560	4.227	.288
Force				
Elasticity				
Twin	.99986	.0105	.000	.992
Pair	.15479	2.3367	5.460	.257

Table 2.

DZ Twins of Opposite Sex: Observed Frequency Distribution

DZ Sex	Twin 1 Male	Twin 2 Male	Twin 1 Female	Twin 2 Female
Mass				
Grapheme	406	588	1682	1269
Spatium	89	137	384	248
Periods				
Marker (SM)	5	7	28	19
Marker (CM)	3	1	6	6
Tech. (TSM)	5	7	22	19
Length				
Block	15	28	88	49
Linkage				
A-dummy	8	16	61	23
O-dummy	8	9	45	16

Table 3.

DZ Twins of Opposite Sex: Derived Volume-Elasticity Measures

DZ Sex	Twin 1 Male	Twin 2 Male	Twin 1 Female	Twin 2 Female
Volume	13.5403	16.6610	22.3867	19.4591
Flow	11.9308	14.7151	19.0545	16.5147
Inertance	-15.4438	-20.0605	-28.1690	-23.7957
Viscosity	-3.5130	-5.3453	-9.1145	-7.2810
Elasticity	-5.1224	-7.2913	-12.4467	-10.2255
Power	-4.0238	-5.9050	-9.2781	-9.2781

Table 4.

Regression Analysis of Natural Periods on Mass

Equation is	$\log_e P =$	$- 4.30 +$	$0.845 \log_e T$		
Predictor	Coef	Stdev	t-ratio	p	
Constant	-4.3043	0.1472	-29.24	0.001	
$\log_e T$	0.84773	0.04609	18.39	0.003	
s = 0.06174	$R^2 = 99.4\%$	$R^2(adj) = 99.1\%$			
ANOVA					
Source	DF	SS	MS	F	p
Regression	1	1.2897	1.2897	338.34	0.003
Error	2	0.0076	0.0038		
Total	3	1.2973			

Table 5.

Regression Analysis of Natural Periods on Blocks for four DZ

Equation is	$\log_e P$ =	- 3.87 +	0.855 $\log_e B$		
Predictor	Coef	Stdev	t-ratio	p	
Constant	-3.8716	0.3867	10.01	0.010	
$\log_e B$	0.8550	0.1056	8.10	0.015	
s = 0.1386	R^2 = 97.0%	R^2(adj) = 95.6%			
ANOVA					
Source	DF	SS	MS	F	p
Regression	1	1.2589	1.2589	65.53	0.015
Error	2	0.0384	0.0192		
Total	3	1.2973			

Table 6.

Regression Analysis of Token Systems on Moment of Text Flow

Equation is	$\log_e$ Twin =	- 0.21 -	0.429 $\log_e$ M		
Predictor	Coef	Stdev	t-ratio	p	
Constant	-0.209	1.491	0.14	0.901	
$\log_e$ M	0.429	0.224	1.91	0.196	
s = 0.9396	R^2 = 64.7.%	R^2(adj) = 47%			
ANOVA					
Source	DF	SS	MS	F	p
Regression	1	3.2343	3.2343	3.66	0.196
Error	2	1.7657	0.8829		
Total	3	5.0000			

Table 7.

Regression Analysis of Token Systems on the Force of Text Flow

Equation is	$\log_e$ Twin =	- 0.383 -	0.329 $\log_e$ F		
Predictor	Coef	Stdev	t-ratio	p	
Constant	-0.383	1.492	0.26	0.821	
$\log_e$ F	0.329	0.162	-2.03	0.180	
s = 0.9046	R^2 = 67.3%	R^2(adj) = 50.9%			
ANOVA					
Source	DF	SS	MS	F	p
Regression	1	3.3635	3.3635	4.11	0.18
Error	2	1.6365	0.8183		
Total	3	5.0000			